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Contribution of Milk Fat to the Flavor of Milk

A. TAMSMA, F. E. KURTZ, R. S. BRIGHT, and M. J. PALLANSCH
Dairy Products Laboratory, Eastern Utilization Research and Development Division [1]
Washington, D.C. 20250

Abstract

To obtain a better understanding of milk fat's flavor contribution to milk we prepared a series of beverages containing 1 to 3% fat, using whole milk concentrate, milk fat, and various vegetable fats as the fat source. All fats except that in the whole milk concentrate were deodorized under two sets of conditions, designed so that one would be more effective than the other in removing volatile compounds. All of the deodorized fats along with undeodorized samples of the same fats and untreated whole milk concentrate were combined with skimmilk. The resultant beverages and the skimmilks used in their preparation were evaluated for flavor and desirability for continued beverage use. Untreated milk fat in whole milk concentrate and partially deodorized milk fat were the only fats which, in the panel's judgment, improved the flavor of skimmilk. The data indicated that the desirable flavor characteristics of milk fat are attributable partly to nonvolatile compounds and also, to a significant extent, to volatile compounds which probably are unique to this fat.

Introduction

Many statements in the literature indicate a general acknowledgment that milk fat contributes positively to the desirable flavor qualities of fresh whole milk. The nature of this contribution, however, is not so clear. Kinsella et al. (1) have stated the viewpoint that fresh milk fat's major flavor contribution is a tactile effect resulting from its colloidal dispersion in the milk. A number of volatile flavor compounds, such as methyl sulfide, acetaldehyde, fatty acids, methyl ketones, and lactones are present in fresh milk. Many of these, while originating in the milk fat, are present in levels below their flavor thresholds.

The question of whether these, and possibly other volatile compounds as yet unidentified, contribute significantly to fresh milk's unique and desirable flavor characteristics has practical as well as theoretical interest. It involves the flavor superiority of milk over that of filled milk. It also concerns the effect that deodorization or other treatment of milk fat may have on the flavor of recombined milk.

To obtain a better understanding of the flavor role of milk fat, we prepared a series of beverages using whole milk concentrate, milk fat, and various vegetable fats as the fat source. All fats except that in the whole milk concentrate were deodorized under two sets of conditions, designed so that one would be more effective than the other in removing volatile compounds. All of the deodorized fats, along with undeodorized samples of the same fats and untreated whole milk concentrate, were combined with skimmilk in proportions which gave a series of beverages of different fat contents. These beverages and the skimmilks used in their preparation were evaluated by a trained taste panel for flavor quality and desirability for regular beverage use.

Materials and Methods

Mixed herd milk from the Agricultural Research Center was separated at 43 C to provide skimmilk and cream. Both were pasteurized at 63 C for 30 min. The skimmilk was concentrated under vacuum to 80% of its original volume, using a bath temperature of 40 C. Pasteurized, homogenized whole milk was similarly concentrated. Milk fat was made by churning the cream, warming the fat to 43 C, and decanting the clear fat through a filter. Refined corn oil (Corn Products Co.,[2] Best Foods Division, New York, New York), refined, edible coconut oil (Drew Chemical Co., Boonton, New Jersey), and "Saffola" safflower oil (Giant Food Store, Washington, D.C.) were used as purchased, except for indicated deodorizations.

Fats were steam deodorized in an apparatus similar to that described by Riemenschneider et al. (3), but modified with a special outlet for measuring the pressure directly above the fat surface, and with larger bore tubing con-

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[1] Agricultural Research Service, U.S. Department of Agriculture.

[2] Mention of brand or firm names does not constitute an endorsement by the Department of Agriculture over others of a similar nature not mentioned.

nections between the fat surface and the cold trap. Deodorizations were performed by flowing steam through 275-g samples of fat at a rate equivalent to 50 ml of water per hour. By using 24/40 joints and 22-mm od tubing, a pressure of 1 mm Hg could be maintained over the fat. By using 55/50 joints and 32 mm od tubing a pressure of 0.1 mm could be maintained. All fat deodorizations were held for six hours at 150 C and pressures as indicated in the tables.

Liquid fats were combined with skimmilk concentrate and water by warming the fat to 43 C, the skimmilk and water to 63 C, and homogenizing the mixture twice at 141 kg/cm^2, using a Manton-Gaulin Model 15-M homogenizer. Deodorized fats were combined in this way immediately after deodorization. Proportions of the ingredients were adjusted to give products with the following compositions: 9.0% total solids, 0.1% fat; 11.0% TS, 0.1% fat; 11.5% TS, 1.0% fat; 12.0% TS, 2.0% fat; and 12.5% TS, 3.0% fat. In each sample, approximately 0.1% fat was derived from the milk fat present in the skimmilk; the source of the remaining fat was as indicated in the tables. In addition to the use of isolated milk fat as a source of milk fat, a similar series of milks was prepared by mixing whole milk concentrate, skimmilk concentrate, and water in the proper proportions.

All samples were held overnight at 4 C and the flavor then evaluated by a ten-man trained taste panel operating with a ten-point scale ranging from 31 to 40 (2). Duplicate samples of each of the five aforementioned products, prepared from one fat only, were tasted at each panel session. The judges were asked to modify their normal scoring to the extent that scores should reflect their personal preferences between samples for regular beverage use.

Results

The highest flavor scores were given to the milks reconstituted from skimmilk and whole milk concentrate. The operations involved in preparing milk fat and recombining the isolated untreated fat with skimmilk invariably introduced off flavors which lowered the flavor score of the reconstituted milk. This was true to an even greater extent with filled milks prepared from coconut oil, corn oil, or safflower oil (Tables 1 and 2 and untabulated data).

Removal of off flavors by steam deodorization of the fats in every instance improved the flavor of reconstituted beverages, compared with those made from the same fats before deodorization. When dealing with corn oil and less unsaturated vegetable fats, deodorization at 0.1 mm was generally somewhat more effective in improving flavor acceptance than the same treatment at 1 mm. When the work was extended to the highly unsaturated safflower oil, however, we found the reverse to be true; deodorization at 1 mm produced a better-flavored product than treatment at 0.1 mm. Milk fat, likewise, was improved more at 1 mm than at 0.1 mm. These findings are discussed in the next section.

From Table 2, milks prepared from whole milk concentrate showed a definite trend toward better flavor with increased fat content. All of the milks prepared from milk fat de-

TABLE 1. Flavor scores of beverages made by combining fats with skimmilk.[a]

Fat source	Fat treatment	Number of experiments	Flavor score
Whole milk concentrate	None	3	37.2
Milk fat	None	15	35.7
Coconut oil	None	1	34.9
Corn oil	None	1	33.3
Safflower oil	None	1	32.6
Milk fat	Deodorized at: 1 mm	3	36.8
Coconut oil	1 mm	2	35.8
Corn oil	1 mm	3	35.0
Safflower oil	1 mm	1	35.1
Milk fat	Deodorized at: 0.1 mm	3	36.0
Coconut oil	0.1 mm	3	36.1
Corn oil	0.1 mm	2	35.0
Safflower oil	0.1 mm	2	33.9

[a] Each beverage contained 3% fat.

odorized at 1 mm were definitely superior to the skimmilk used in their preparation, but showed little flavor variation between the three fat levels. Within the series prepared from milk fat deodorized at 0.1 mm, there was no panel preference for any of the milks, skim or with added fat.

Data which we have not tabulated showed that coconut oil deodorized at either pressure was similar to milk fat deodorized at 0.1 mm, in that the panel had no preference between skimmilk and any of the filled milks. With the more highly unsaturated corn oil, the panel showed no preference between the three fat levels, but all of these scored about one flavor point below the skimmilk. The flavor scores of all filled milks utilizing safflower oil were lower than those of skimmilk and decreased substantially with increasing fat content.

These results, as reported, were true not only of the average but also of the individual experiments of each series dealing with a similarly treated fat. The flat panel response to skimmilk and beverages containing either milk fat deodorized at 0.1 mm or coconut oil deodorized at either pressure, while repeatable from experiment to experiment, was the resultant of consistent differences between judges, some of whom were indifferent to the added fat while others liked it and still others disliked it.

Discussion

The score card used by the Dairy Products Laboratory taste panel provides a scoring range of 31 to 40. In practice, this has been compressed so that a high-quality fresh whole milk is scored about 37. The scoring was developed primarily for evaluating whole milks on the basis of freedom from flavor defects. It was felt that this criterion, by itself, was inadequate for investigating milk fat's flavor contribution. Accordingly, the judges were asked to modify their normal scoring to the extent that their ratings would parallel their personal preference for continued beverage use.

Our data show that the fats can be separated into three groups: 1) those making a favorable flavor contribution, 2) those to which the panel was indifferent, and 3) those damaging the flavor of the beverage when combined with skimmilk. In the first group are unmodified milk fat in whole milk concentrate and milk fat deodorized at 1 mm. In the second group are milk fat deodorized at 0.1 mm, coconut oil deodorized at either pressure, and undeodorized milk fat. In the third group are corn oil and safflower oil under all of our experimental conditions, along with undeodorized coconut oil.

The taste panel found oxidized flavor in beverages prepared from deodorized safflower oil. Apparently, the antioxidant present when this oil was purchased (propylgallate) was more completely removed at the lower deodorization pressure, thus accounting for the lower flavor score of this oil when deodorized at 0.1 mm.

Milk fat deodorized at 0.1 mm and coconut oil deodorized at either 0.1 mm or 1 mm, judging from panel averages, seemed to be devoid of any flavor, whether derived from volatiles or from nonvolatile compounds, since the flavor scores at all fat levels were nearly identical with that of skimmilk (Table 2 and text, above). There were indications from the scoring of individual judges, however, that this was not entirely true. While some judges showed a nearly flat response to increased fat content, others showed increased flavor criticisms and still others, increased acceptance. This was found in the individual experiments as well as in the averages of all of the experi-

TABLE 2. Effect of the concentration of milk fat and its prior treatment on the flavor of reconstituted milks.

Source of milk fat	Fat treatment	Flavor score				
		9% TS 0.1% fat	11% TS 0.1% fat	11.5% TS 1% fat	12% TS 2% fat	12.5% TS 3% fat
Whole milk concentrate	None	35.9	36.2	36.8	37.0	37.2
Milk fat[a]	None	.....	.....	.....	.....	35.7
Milk fat	Deodorized at 1 mm	36.0	36.2	36.6	36.6	36.8
Milk fat	Deodorized at 0.1 mm	35.9	36.1	35.9	35.9	36.0

[a] Average of 15 experiments; data of three experiments each were averaged for other fats.

ments. All of these results are explainable within the framework of (1) known individual variations in sensitivity to off flavors and (2) the dual hypotheses that a) off flavors were still present, to some extent, in the deodorized fats, and b) nonvolatile fat compounds do contribute to flavor acceptance.

The data of Tables 1 and 2 are significant in showing that untreated milk fat, from whole milk concentrate, and partially deodorized milk fat (1 mm) are the only fats found by the panel as a whole to improve the flavor of skim-milk. There was no indication that the results with milk fat had been affected by overnight oxidation. Furthermore, from the preference for the less completely deodorized milk fat we concluded that it contained volatile flavor compounds which significantly and favorably modified the flavor of the nonvolatile portion of the fat. The deodorization procedures converted much of the milk fat's flavor potential into flavor compounds which were removed by volatilization. Apparently, the levels of these compounds retained at 1 mm were sufficiently similar to those in fresh milk fat present in whole milk concentrate to give the recombined milk a desirable flavor approaching that of fresh milk.

If we define volatility in terms of significant concentration changes under our deodorization conditions, we can state that the desirable flavor characteristics of milk fat appear to be attributable partly to nonvolatile compounds and also, to a significant extent, to volatile compounds which probably are unique to this fat.

References

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